Instrumentation in DESIREE

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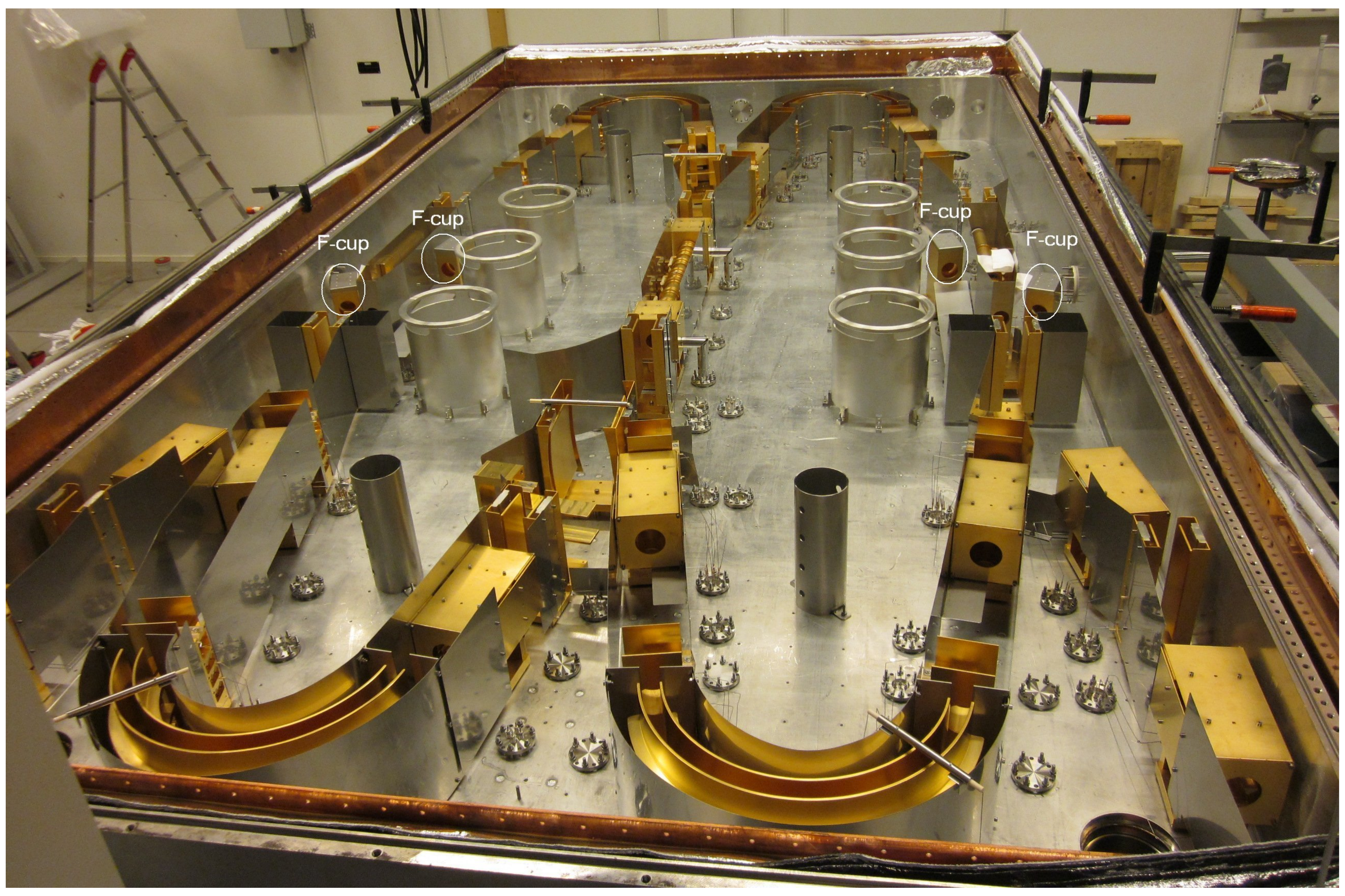


Introduction to DESIREE

DESIREE is a double electrostatic storage ring at the Department of Physics at Stockholm University. The two rings have similar circumferences, 8.7 m, and a common straight section along which stored ions can interact. The ion optics is housed in one single, double walled cryostat and is cooled to around 13 K by four cryogenerators. Two injectors are able to supply both positive and negative ions to both rings.

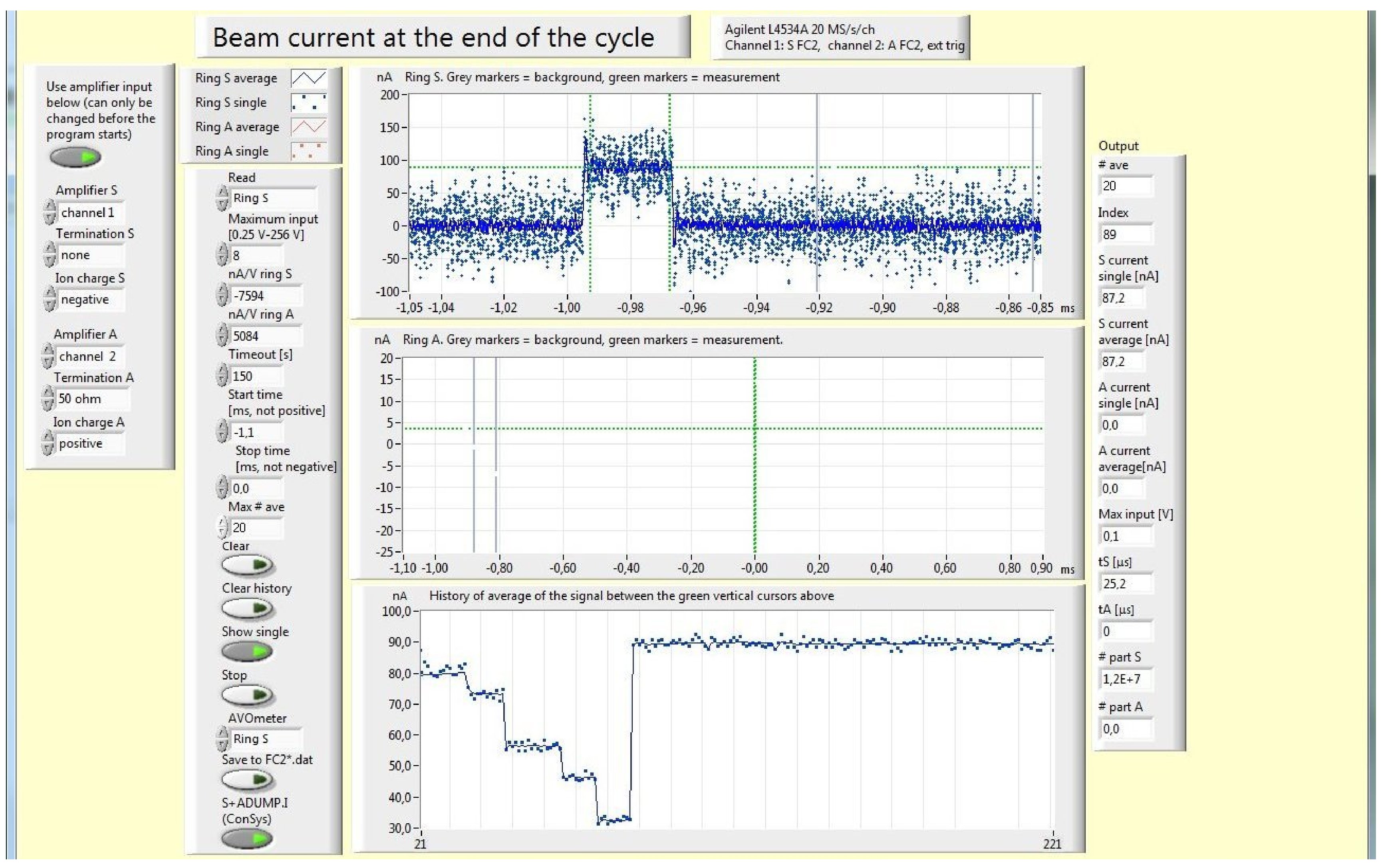
In ring A, the asymmetric ring, two quadrupole doublets are displaced to permit the installation of two extra bends (D1, D2) on each side of the common section. These are necessary to simultaneously store ions with different energies. Two bends (D3) are common for both rings, they bend 10° in ring S and 0.5-10° in ring A, depending on the ion energy in ring A.

Ions can be stored in ring S with lifetimes of several minutes. The lifetimes in ring A are shorter, in the order of several seconds. This is not surprising since the dynamic aperture in ring A is much smaller than in ring S.

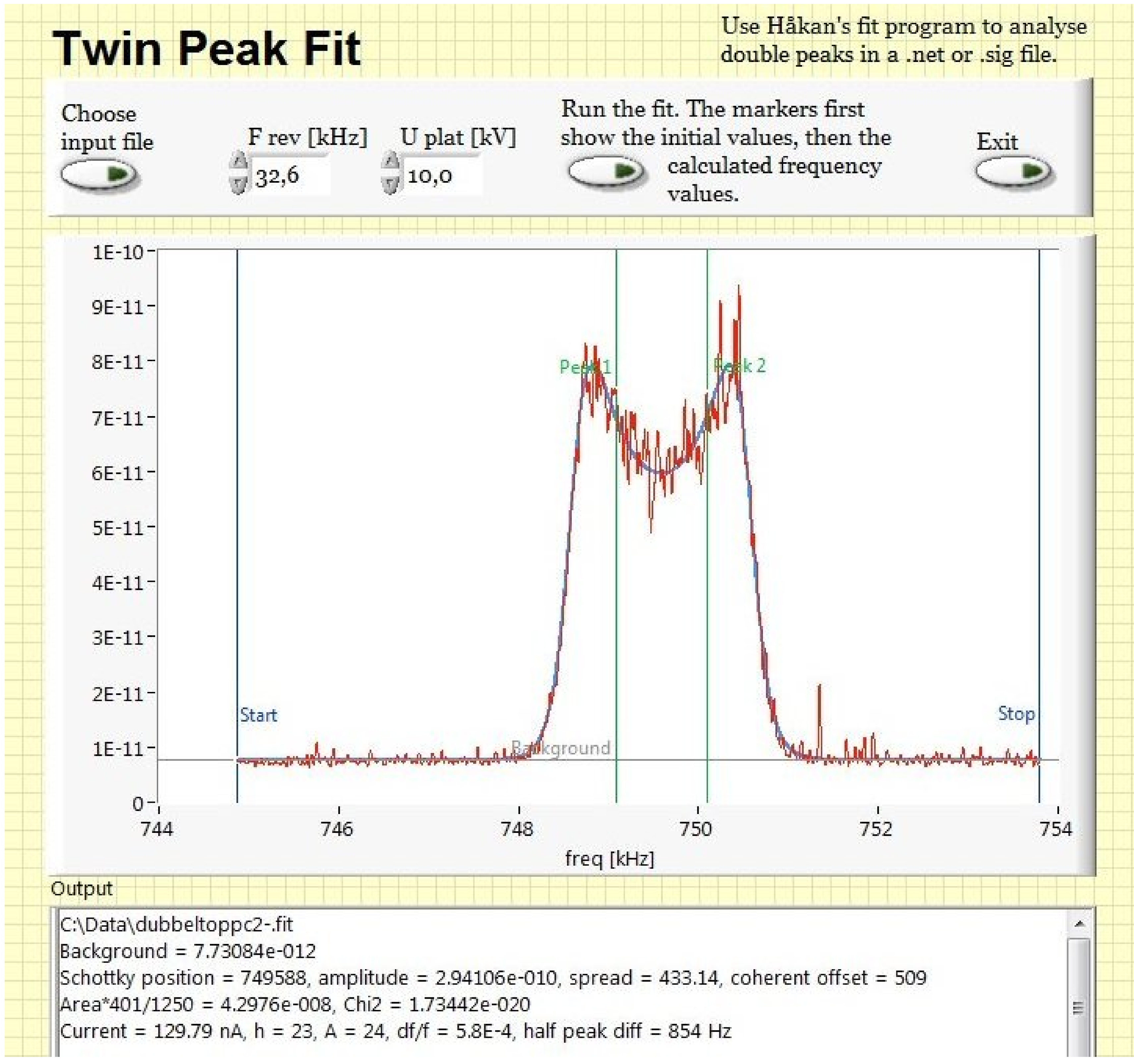
Measurements of stored ion current

The most straightforward way to measure the stored ion current would be to use a DC current transformer (DCCT). However, there is no DCCT installed in Desiree and the stored currents are often weak, often only a few nA, so a DCCT would mostly be too noisy to measure such currents. Instead we are using two other methods.

The kickout method
The figure below shows the measurement of the stored current obtained by kicking the stored beam into a Faraday cup which is installed just outside the injection kicker. The use of this method is advantageous, since when the polarity of the injection kicker is reversed to prepare the ring for a new injection, the beam is automatically kicked into the outside cup, which is placed 18° outside the stored beam. The aperture of the cup is large enough to accept all of the beam which is kicked to 20° with respect to the stored beam. The figure below shows the panel of the LabVIEW program which is used to handle the measurements.
Further developments of this system include the design of an optimized amplifier for the pulsed current and efforts to reduce the noise in the measurements.

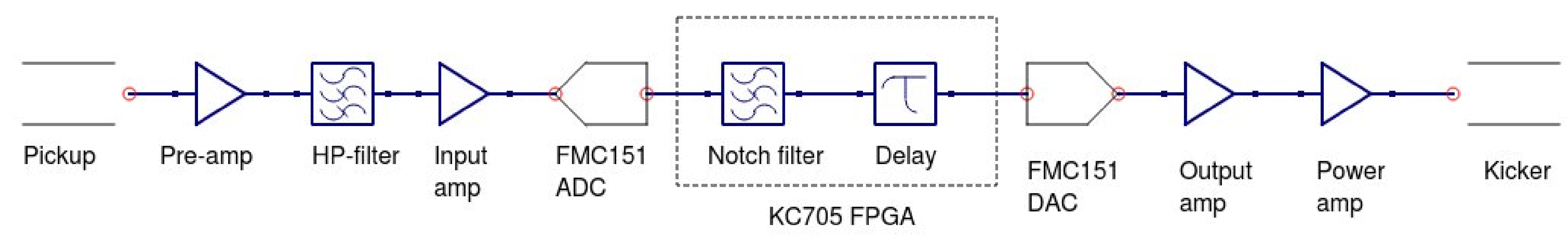


The double-peak method
If the beam is cold enough, the individual Schottky peaks can split into a double-peak structure. In this case, the split of the peaks is proportional to the square root of the circulating beam current. The theory for this phenomenon is described in ref. 1. The figure below shows another LabVIEW program which fits the measured Schottky peak to the expression in ref. 1 and presents the results. The formula contains the ratio between the radii of the beam pipe and the beam, a value which is not well defined in Desiree, since there is actually no beam pipe. Thus the current from the fit has been calibrated with the help of the current in the cup using the previous method.

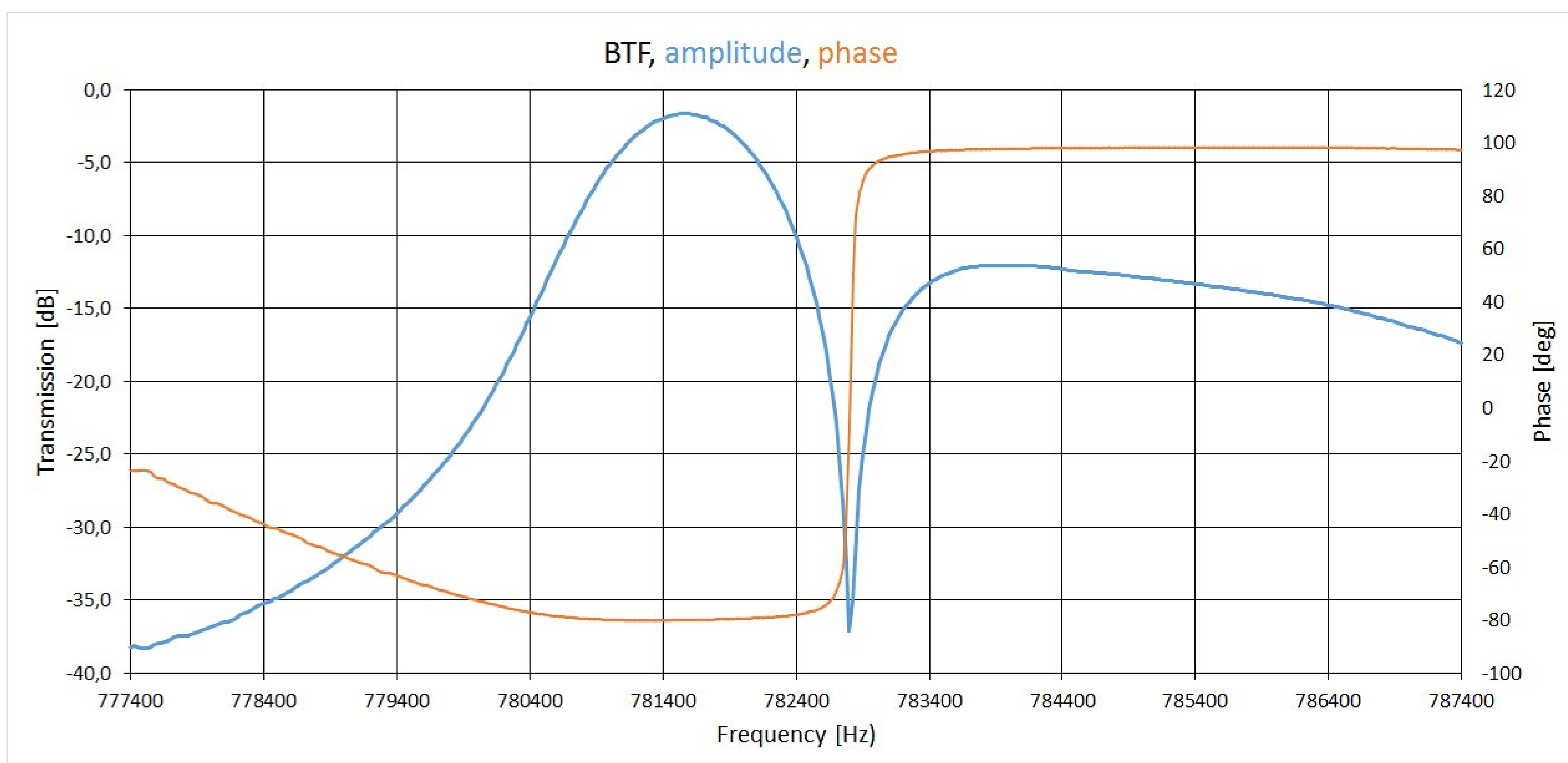


Preparations for stochastic cooling in Desiree

Calculations of stochastic cooling in Desiree have shown that it should be possible to achieve cooling times around 100 s (ref.2). Since the lifetimes of the beams in the S-ring mostly are much longer than this, a project to implement stochastic cooling has been initiated. The instrumentation used for the first tests, including an FPGA based digital notch filter, is shown below.



For the initial tests, there is no possibility to install dedicated pickups and kickers, so the existing RF drifttube and a pair of transverse steerer plates have been used as longitudinal pickup and kicker, resp. BTF measurements, such as the one below, seem to indicate that the available instrumentation should be appropriate to achieve cooling.



BTF measurement of a 10 keV C_2^- beam at 24th harmonic

References
1)Ordered Ion Beams in CRYRING, H. Danared et al., COOL2001
2)Applicability of Stochastic Cooling to Small Electrostatic Rings, H. Danared, EPAC 2008